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A REMARKABLE FORM OF FUNARIA HYGROMETRICA.

H. N. Dixon, M.A., F.L. S.

Cases of teratology in mosses do not seem common, and as far as they have come under my notice they appear usually to belong to the sporophyte. In the oophytic generation I have a leaf of *Campylopus* which is forked, nerve and all, for half its length, and in *Barbula convoluta* var. *Sardoa* I have frequently found the hyaline apical cell bifid or double. These appear to be cases of pure teratology of a more or less pathological kind. The structure which I am about to describe while equally abnormal is totally different in its nature. and possibly functional rather than pathological.

Among some material of *Physcomitrella patens* sent me by Mr. Evans for examination, collected on half dried mud at the upper end of Tonduff Reservoir, in the Pentland Hills of Midlothian, by Mr. W. E. Evans, in Oct., 1908, was a taller Funarioid moss which on examination proved to be the ♂ plant of *Funaria hygrometrica.* The antheridia were approximately mature, and the lateral ♀ shoot was just beginning to be developed from the axil of a lower leaf.* The plants were normal so far as I could ascertain, with the exception of the margins of the perigonial bracts, which exhibited a remarkable, and in all the material sent a constant structure.

The bract of the ♂ flower in *F. hygrometrica* so far as I am aware presents normally the same variation in marginal denticulation as that of the ordinary foliage leaves, i. e., they are usually moderately denticulate at the apex, ranging from quite entire to distinctly toothed. Thus most systematic works simply describe them as "denticulate at apex," and they are so figured in the Bry. Europæ. Wilson (Bry. Britannica) describes them as "denticulate at the apex, and still more evidently so at the base;" and this is the only description I have found in which anything like an approach is hinted at to the peculiar structure of the bracts of the Tonduff plant, and certainly does not represent the usual condition of the bracts in *F. hygrometrica*, which are generally entire or nearly so in the lower half.

In the Tonduff plant the ♂ bracts presented a very striking appearance, the margins throughout almost their whole length being furnished with closely set and often double serratures, forming a very remarkable and pretty fringe or frill (cf. Fig. 1). The structure was best marked on the two or three innermost bracts, but was present in a less marked degree on the succeeding ones, the outermost only, like the stem leaves, being of the normal character, entire, or only slighly toothed towards apex. At first sight the serratures reminded one of the double row of teeth in *Catharinea* or in the Bi-serratæ section of *Mnium*, only with the teeth much more obtuse (cf. Fig. 2); closer examination however showed the resemblance to be illusive, the structure being quite different and more complex. The twin teeth in *Catharinea* and *Mnium* spring from two adjacent cells of the thickened limb or border, and could scarcely, it may be presumed, be developed from a unistratose border. In the *Funaria* the effect is in part produced by a row of turgid marginal cells, each spreading out from a narrow base into a sort of hammer-

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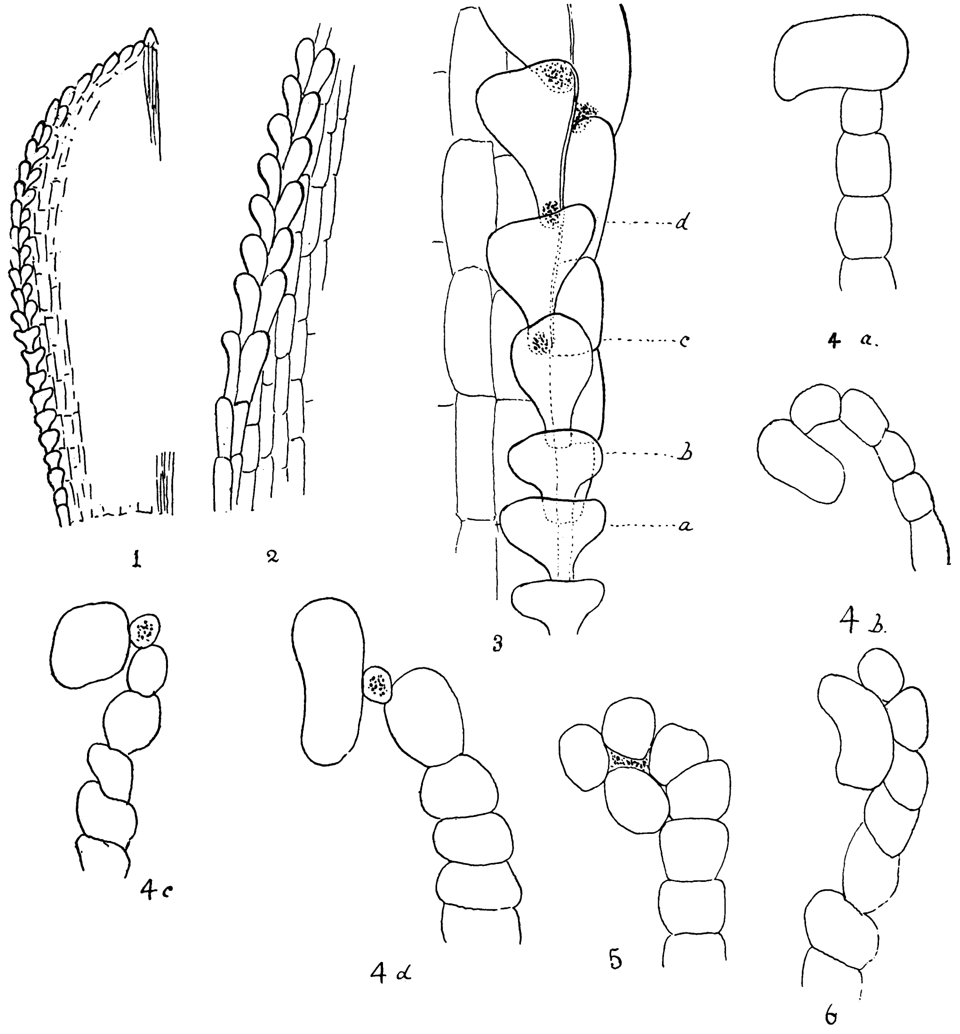
*Cf. Boodle, Annals of Botany, Vol. XX, No. LXXIX, July, 1906.



Del. H. N. Dixon. Drawing reduced ¼.

EXPLANATION OF PLATE V.

1. Margin of bract, ×25. 2. Portion of margin, ×80. 3. Margin towards base of bract, ×160. 4, 5, 6, do., in transverse section, ×160. [N. B. Fig. 1 shows the bract viewed from the back; Figs. 2-6 show marginal view, with ventral surface of bract to right, dorsal surface to left.]

head apex, frequently semilunar above (comparable in form to the section of the apical cell of lamellæ in *Polytrichum commune*, but usually asymmetrical); (cf. Fig. 3a.) These cells are connected with the adjoining cells of the next row by only a very narrow attachment, the greater part of their surface being free; they are frequently almost without chlorophyll grains above, with a dense mass of chlorophyll collected at the extreme base or proximal end.

In addition to this marginal row of cells, the succeeding rows (cf. Figs. 1, 2), are also frequently extremely turgid, clavate, and so strongly protuberent at the upper or distal end as to be free from contact with the adjacent cells except by a very small proportion of their surface. The structure is further complicated by the recurving of the margin, which varies greatly in extent in different bracts and in different parts of the same bract. When the margin is erect, which is usually the case near the base of the leaf, the appearance is as at Fig. 3a; higher up the bract, as it gradually recurves, the ventral surface of the protuberant subjacent cells comes more and more into view, as at Fig. 3c, d; and when this protuberance becomes strongly marked and these adjacent cells are almost free at their apex the appearance shown in Figs. 1,2, is caused, giving the appearance of a double frill to the bracts. This may be still further enhanced by the margin becoming more strongly recurved, and by several rows of subjacent cells exhibiting turgescence and protuberance, though it is never so markedly presented by these as by the first and second marginal rows.

This structure is somewhat elucidated by cutting transverse sections of the bract. Figs. 4, 5, 6 illustrate various points on different bracts, with differing degrees of recurving of the margin. The letters a, b, c, d, in Fig. 4, correspond to the positions of the equivalent lettering in Fig. 3, the sections being taken at these points (or at least at corresponding points, since the sections were not all actually made from the same bract).

Figs. 5, 6. show the remarkable degree of recurving sometimes attained, so that the marginal cell is at times in close contact with three or even more rows of cells, and appears to be and probably is adherent to their cell-walls, as is often the case in species of *Grimmia* and *Barbula*, where the closely recurved margin of the lower part of the leaf gradually becomes transformed into the bi-stratose thickened margin of the apical part.

The question naturally arises as to what is the genesis of this remarkable, perhaps unique formation. Is it an adaptation to a special environment, or a reversion to an ancestral type, or is it a merely fortuitous sport due to abnormal conditions of growth? I am not able to give any satisfactory reply: I can only suggest one or two ideas which have occurred to me, and perhaps some reader will be able to frame an explanation.

There can be but little doubt that the primary end attained by this abnormal cell development is the storage of an increased quantity of water or at any rate moisture, an end attained to some extent also by the capillary attraction of the recurved margin. The resemblance of some of the turgid marginal cells to the "flask-cells" of the cortical stem-layer in *Sphagna*, e.g. *S. molluscum*, at once strikes the eye, and the group of cells looked upon as storage cells for water at the base of some Sphagnum leaves provides a further analogy. Another point that attracts the attention in examining a flower of the Tonduff plant is the close resemblance between the turgid marginal cells nearest the base of the bract (*e. g.* b, Fig. 3) and the uppermost cell of the swollen clavate paraphyses; so much so that I have frequently been in doubt whether I was looking at one or the other. This turgescence of the apical cell of the paraphyses of the ♂ flower is characteristic of certain large groups of mosses, and will be found usually correlated with a dioicous or autoicous inflorescence, large discrid ♂ flowers, and lax areolation. It obtains, for instance, almost throughout the *Splachnaceae*, *Funariaceae* and *Mniaceae*; and its special correlation with the male organs is manifested by the fact that not only are the ♀ paraphyses in these cases almost without exception filiform, but even in certain synoicous species, e. g. of *Mnium*, the paraphyses surrounding the antheridia are markedly clavate, while those in proximity to the archegonia are of the more usual, filiform shape.

The paraphyses in these cases act, no doubt, as reservoirs for keeping the antheridia properly moistened. The antherozoids, in exact contrast with the spores of the mature capsule, require conditions of moisture to perform their proper functions. They are in fact aquatic organisms, and their constancy in this respect throughout whole groups of the Cryptogamia suggests that this feature is an inherited character retained ever since the emergence of their primeval algoid ancestor from its aquatic home to find a new environment on *terra firma.* May we pre-suppose a primitive ancestral *Funaria* with its sporophyte already well developed, but with the vegetative organs as yet confined to the protonema with its algoid structure, as in the remarkable *Ephemeropsis Tjbodensis* of Java; having its antheridia surrounded by water reservoirs in the shape of turgid paraphyses, possibly also with turgid end-cells to the branches of the protonema, the "Assimilations-organen" of the Ephemeropsis? And may we see in these paraphyses, or in this protonemoid development, the beginning of the structure afterwards to be evolved into the foliar organs, commencing with the bracts surrounding the antheridia? In this case the marginal cells of the newly evolved foliar structure would probably be turgid as in the bracts of the Tonduff *Funaria*, and it would only be in the later stages, as the foliar organs developed a greater expanse of lamina, that these special reservoir cells would be dispensed with, and the margin take the normal, simple structure of the rest of the leaf. If so we might possibly see in the bracts of the Tonduff plant a reversion to a type midway between the organs of the supposititious ancestral leafless plant and those of the present normal *F. hygrometrica.*

Whatever be the explanation of the structure, it would appear from Wilson's description quoted above that there is a certain plasticity about the male bracts in this species, as regards the serrature of their margins, and the student would do well to keep an eye on them with a view to throwing further light on the problem involved.

I have to express my thanks to Mr. L. A. Boodle, of the Jodrell Laboratory, Kew, for assistance and suggestions.

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